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ABSTRACT

Research related students' orientation toward college and college majors to their attitudes toward computer-assisted instruction (CAI) and their performance in an organic chemistry course using CAI. Major findings were that: 1) students majoring in applied fields manifested more favorable attitudes toward both organic chemistry and CAI, than did students majoring in natural science; 2) students majoring in natural science received higher grades than those in applied fields; and 3) attitude was negatively correlated with course grade. These results were interpreted with caution, due to the small numbers of students involved, the limited portion of the course which used CAI, and the absence of a control group. Nevertheless, they seemed to imply that there were differential benefits of CAI for students with different majors and that CAI was more useful to poorer students since it provided a structure for learning science which they previously lacked. Since grades improved in the second semester, it appeared that CAI's contribution accelerated over time. The development of orientation programs to improve the attitudes of students toward CAI was recommended. (PB)

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THE INFLUENCE OF STUDENTS' ORIENTATION TOWARD COLLEGE AND COLLEGE MAJOR UPON STUDENTS' ATTITUDES AND PERFORMANCE IN A COMPUTER-BASED EDUCATION COURSE[1]

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Introduction

Computer-based education (C-BE) techniques are being increasingly applied in the educational process as universities seek to individualize instruction and find better ways to provide large numbers of students with the opportunity to assimilate the fundamental principles and procedures of their disciplines. C-BE can provide individualized drill and practice in the lower level skills which are basic to a high level of mastery in a number of academic disciplines without the demands upon the time of faculty and advanced students which are inherent in traditional pedagogical strategies.

C-BE can structure the learning experiences of large numbers of students without the continual attention and intervention of an expert teacher. This reduction in formal teacher-student contact makes it necessary to carefully evaluate both the overall gains in learning which may be realized from a given C-BE procedure and the degree to which students' backgrounds, aptitude, and orientations benefit from C-BE programs.

The present paper is a partial report of an effort to evaluate student

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characteristics related to performance in an introductory organic chemistry class employing drill and tutorial C-BE modules. This effort was carried out in the context of the SCRAPE model of educational program evaluation (Liberty, 1972). Liberty posited that Output Behaviors (in this case, grades in the organic chemistry class) can be viewed as a joint function of: (1) Curricular characteristics of an educational program such as the pedagogical techniques employed, the mode of C-BE used in the course, testing strategies, etc.; (2) Educational environment characteristics such as the competence and attitude of the instructor, the convenience or difficulty of obtaining the resources necessary to fulfill class requirements, the prevailing attitude toward the course, etc.; and (3) Student entering characteristics, including students' social class, ethnic background, personality traits, and scholastic aptitude.

Curricular and Educational Environment Characteristics

The introductory organic chemistry course, CH818a-b, is a two semester, eight credit hour course. The course consists of two 50-minute lectures per week, an optional 50-minute discussion section and a required 4 hours laboratory period each week.

In addition to these traditional aspects ot the course, twenty-one computer-based lessons (average length 35 minutes) were introduced in the C-BE sections as a requirement. These lessons included both the presentation of tutorial material on essential concepts in organic chemistry and drill in the application of computational procedures and organic chemistry terminology. The students were permitted to schedule their interaction with computer lessons as they chose, within the hours when terminals were available. A criterion performance level of 85 per cent was established for successful completion of each lesson.

Student Entering Characteristics and Outcome Measure

Data for variables of interest were available on 12 of 28 students who completed both semesters of an introductory organic chemistry course using C-BE modules during the 1972-73 academic year. For the Orientation Toward College Inventory, data are also presented for a comparison group of 22 students enrolled in a conventional (non C-BE) section of the introductory organic chemistry class. This second section of CH818a-b was taught by a different instructor.

Major. The students were classified according to their declared major field. For the purpose of comparison, students majoring in applied fields were analyzed separately from those majoring in natural science fields. For the students in the C-BE section, the Applied Group (N=6) was comprised of chemical engineering (N=1) and pharmacy (N=5) majors, while the Natural Science Group was made up of chemistry (N=5) and biology (N=1) majors. In the conventional instruction section the Applied Group (N=15) was comprised of pharmacy majors (N=10) and chemical engineering majors (N=5). The Natural Science Group (N=7) was comprised of 5 chemistry majors, one microbiology major and one zoology major.

Aptitude. SAT scores were obtained for all students in the C-BE section.

Attitude Toward C-BE. Each student in the C-BE section filled out an attitude questionnaire during the Fall Semester and again during the Spring Semester. The questionnaire asked for ratings of "Chemistry" and of "The Computer as a Study Aid" on two separate, ten-item, semantic differential scales.

Orientation Toward College. The Orientation Toward College Inventory (OTC), an experimental measure of values and goals in education was administered to all students enrolled in both sections of organic chemistry during the Spring Semester. The OTC consists of brief paragraph descriptions of four "personal philosophies" which characterize a range of attitudes about the purpose of higher education.

Students rank the philosophies in the order that they hold the beliefs expressed on the inventory. The Vocational philosophy stresses higher education as career preparation. The Academic philosophy emphasizes the development of the intellect and the value of education as scholarly endeavor. The Social philosophy stresses extracurricular activities and social life as one of the most important aspects of a college career. And the Identity-seeking philosophy stresses the importance of individualism and a search for the meaning of life.

Outcome Measure. The outcome measures in the C-BE section were the students' course grade for both semesters. Grades were assigned on the basis of the number of points earned by each student out of a maximum possible of 1700 points awarded for performance on exams, in the laboratory, and on the computer modules. Students who achieved the 85% criterion on 20 of the 21 computer modules earned 150 points toward the above total. Ten points were deducted for each lesson not completed below the 20 module minimum.

Since differences in the grading systems and in course content invalidated direct comparison of performance in the C-BE and conventional sections, grades are not reported for students in the conventional sections.

Results

Grade in Course

Table 1 includes a breakdown of course grade data for Applied and Natural Science majors in the C-BE section for both Fall and Spring semesters. In the first semester of the course (Fall) the Natural Science group (Mean Grade = 3.17) did considerable better than the Applied group (Mean Grade = 2.00). This difference was tested by a single classification analysis of variance and was found to be significant at the .05 level, ($F = 4.89$; 1, 11 df).

During the second semester, the Natural Science group performed at the

same level as during the Fall (Mean Grade = 3.20) while the Applied group improved considerably (Mean Grade = 2.60). No significant differences were found between the means for Spring Semester grades.

Scholastic Aptitude Scores

Mean SAT scores for both groups on the Verbal and Quantitative sections of the test as well as total scores are presented in Table 1. There was a substantial difference between the mean verbal scores for the two groups (Applied = 482, Natural Science = 626; F = 6.05, p = .03 for 1, 11df).

The Quantitative section of the SAT revealed no significant differences between the two groups of students (Applied = 641, Natural Science = 682). But the superiority of the Natural Science group was again evident on the total score (Applied = 1123, Natural Science = 1308; F = 4.50, p = .06; 1, 11df).

Pearson product-moment coefficients of correlation were computed for all three SAT scores and Fall and Spring course grades. Only the SAT-Verbal vs. Fall course grade comparison (r = .58) reached to .05 level of significance.

Attitude Scales

All of the students tested showed a substantially positive attitude both toward the computer and toward the subject matter of chemistry. The Applied group was more positive than the Natural Science group on each of the administrations (Spring and Fall) of the two attitude measures (see Table 1) and in the case of Attitude toward the Computer as a Study Aid - Fall, the mean attitude score was significantly more positive for the Applied group, (Applied = 23.67, Natural Science = 31.50, F = 4.76, p = .05, 1 and 11df).

Coefficients of correlation were computed between course grade for both semesters and the two scales of the attitude instrument. The Fall administration of the Attitude toward the Computer as a Study Aid scale correlated

negatively with both the Fall course grade ($r = -.54$, $p = .05$) and Spring Course grade ($r = -.65$, $p = .01$). Further, the Fall administration of the Attitude toward Chemistry scale correlated negatively with Spring course grade, ($r = -.54$, $p = .05$). The findings indicate although the Applied Science group made lower grades, they had more favorable attitudes both toward chemistry and toward the computer.

Orientation Toward College Inventory (OTC)

Table 2 presents the rankings which each student in the two groups in the C-BE section assigned to the four philosophies of the OTC as well as mean ranking of each philosophy. For both groups a ranking of 1 indicates the highest agreement with the philosophy while a ranking of 4 is the lowest rating.

Overall, the Natural Science group strongly favored the Academic philosophy (mean = 1.59) and ranked the Vocational (mean = 2.67), Social (mean = 2.83), and Identity-Seeking (mean = 3.00) philosophies as second through fourth in that order. The Applied group, on the other hand, favored the Vocational philosophy (mean = 1.83) with the Social philosophy (mean = 2.00) as a close second and the Academic (mean = 2.67) and Identity-Seeking (mean = 3.67) philosophies rated as third and fourth respectively.

Within the Applied group, the pharmacy majors tended to rate the Social philosophy as highest and the chemical engineers favored the Vocational philosophy. The chemistry majors in the Natural Science group gave the Academic philosophy either the first or second ranking, while the lone biology major chose the Identity-Seeking philosophy.

Table 3 presents the rankings which each student in the conventional section applied to the four philosophies of the OTC as well as the mean rankings for the Applied and Natural Science groups. In the case of the Applied group, the pattern of the mean rankings was the same as in the C-BE section; Vocational

first (mean = 1.47), Social second (mean = 2.27), Academic third (mean = 2.60), and Identity-Seeking fourth (mean = 3.67).

The Natural Science group in the conventional class differed from their counter-parts in the C-BE section in that the Vocational philosophy (mean = 1.57) received the highest mean ranking, while the Academic philosophy (mean = 2.00) dropped to second rank. The Social philosophy (mean = 2.83) and the Identity-Seeking philosophy (mean = 4.00) remained as the third and fourth choices respectively.

For students in the C-BE section correlation coefficients were computed between the mean ratings of each of the four philosophies and the attitude measures. The Academic philosophy correlated negatively with the Fall administration of the Attitude toward Chemistry Scale, ($r = -.67$, $p = .01$). The Social philosophy correlated negatively with the Fall administration of the Attitude toward Chemistry Scale ($r = -.50$, $p = .05$) and positively with the Fall administration of the Attitude toward the Computer as a Study Aid Scale ($r = .53$, $p = .05$). No significant correlations were observed between any of the four philosophies and the Spring administration of the attitude scales.

Discussion

The pattern of the performance data may indicate that students majoring in applied fields and those majoring in chemistry or biology derived a differential benefit from the C-BE instructional technique. The natural science majors achieved a relatively high level of performance during the Fall Semester and maintained it during the Spring. The applied majors achieved only a 2.00 mean grade in the Fall but their performance improved markedly to a mean of 2.60 at the end of the Spring Semester. This trend can be viewed as a function of the fact that the Applied group derived a greater cumulative benefit from the C-BE instruction over two semesters which was evidenced by their improved performance in the Spring.

It might be that the structure imposed by the C-BE modules and the immediate feedback on performance helped the students who were less familiar and comfortable with organic chemistry to acquire effective techniques for covering the material which the Natural Science group had acquired earlier in their academic careers.

The SAT scores obtained for the two groups showed a significant difference in verbal and total scores favoring the Natural Science group. Unsuprisingly, a student's aptitude as well as choice of major must be considered as a potential predictor of the benefit which the student will derive from a C-BE learning experience. A larger sample of students majoring in applied fields will have to be evaluated before the relative influences of personality-attitude factors versus a simple aptitude factor upon performance can be assessed.

Inspection of the attitude data reveals that the Applied group which performed at a lower level actually manifested a systematically more positive attitude both toward the computer as a study aid and toward chemistry than the Natural Science group.

A possible explanation for a more favorable attitude toward the computer as a study aid on the part of the Applied group is that the chemical engineering and pharmacy majors may have had more prior experience with computers or may have had a stronger set to view computers as valuable tools in their chosen professions than did the Natural Science group. This does not seem likely, however, for two reasons. First, CH818 is a sophmore level course and none of the students in any of the four major fields encountered a formal introduction to computers in their academic programs prior to their junior year. Second, there is no reason to believe that students in the Applied group would acquire more informal experience with computers than would the Natural Science group.

A second explanation which is more likely in the light of the data, is that the Applied group was more favorably disposed toward the computer because it was of more benefit to them. Students who find that drill and practice on the

computer helps them to master the material and obtain better grades would be expected to have a more positive attitude toward it than would students who derived no substantial benefit in terms of course grade.

There is no obvious a priori reason why the Applied group should also manifest a more positive attitude toward chemistry than did the Natural Science group. The fact that the differences on neither the Spring nor the Fall administration of Attitude Toward Chemistry Scale reached statistical significance may indicate that the difference between the groups on this scale was the result of a small response bias on the part of the Applied group.

It is also possible that the more favorable attitude toward chemistry on the part of the Applied group is a function of their perception of the organic chemistry class itself. Dr. Stotter, the instructor of the C-BE class reports that organic chemistry has a widespread reputation among chemistry majors as being a time consuming and tedious class in comparison with other courses in the major sequence. Thus the Natural Science group may be reflecting negative bias towards organic chemistry in particular. The Applied group, on the other hand, may view the course more positively since they have a different body of previous experiences. No conclusions are warranted in this area until more complete attitude norms are established for the populations being studied.

Finally, one possible explanation for the initially poorer performance on the part of the Applied group is that they entered the course with an unrealistically favorable attitude to chemistry and C-BE. If such were the case the Applied group may have been caught unawares by a difficult and time consuming course and it may have taken them until the second semester to acquire efficient strategies for mastering the material.

The OTC is still in the developmental stages so the implications of the ratings of the four scales are not yet clear. But the relationship between the

scale scores contributes to the overall picture of the students who took part in this study.

In both the conventional and the C-BE sections the Natural Science group was more favorably disposed toward the Academic philosophy than was the Applied group. And in the C-BE section the Natural Science students as a group ranked the Academic philosophy as first ahead of the Vocational philosophy.

Finally, the Applied groups in both conventional and C-BE sections ranked the Academic philosophy as their third choice behind the Vocational and Social philosophies.

Although the differences between means are relatively small and were not tested for significance, the trends described are consistent with the kinds of career preparation being pursued by the two groups. Students majoring in pure science fields might be expected to be more academically oriented while students majoring in applied fields would tend to have more practical concerns.

The significant negative correlation between the Academic philosophy and attitude toward chemistry for students in the C-BE section is consistent with the fact that the more academically oriented Natural Science group had a less positive attitude toward chemistry. And it would be expected that adherence to the Social philosophy which was more prevalent in the Applied group would correlate positively with the Social philosophy which was predominant among the Applied group. No explanation for this discrepancy is immediately evident. It does seem, however, that the Social philosophy of the OTC may tap a dimension of attitude which cuts across the category of applied versus natural science college major. Analysis of data collected during the 1973-74 academic year is expected to provide more information on the validity of the scales of the OTC, particularly the Social philosophy.

Three factors dictate that the results reported in the present study be regarded as quite tentative. First a relatively small sample of the students

enrolled in the C-BE and conventional organic chemistry courses were tested and the generality of the trends reported has not yet been established. Second, it was not possible to obtain a performance measure which was directly related to the C-BE segment of the course. The computer modules had a relatively small influence on the course grade and it can only be inferred that observed differences in performance were a function of the effect of C-BE. Thirdly, performance and attitude data from students in a comparable conventional (non-C-BE) class was not available as a control.

Data from a much larger sample of students have been collected during the Fall of 1973 and is currently undergoing analysis. It is expected that these data will provide a firm basis for confirming or disconfirming inferences drawn from the data in the present study.

With the above reservations in mind, several trends in the data can be viewed as having potential significance for the development and dissemination of C-BE materials for use in introductory science classes. The most clear cut trend was the increment in performance for the Applied group across the two semesters. If this finding is replicated it may indicate that students with less intrinsic motivation to master the subject matter and/or lower scholastic aptitude stand to benefit the most from C-BE of this type.

A second trend which emerged from the present data was the more positive attitude on the part of the Applied group. This more favorable opinion both towards C-BE and toward chemistry may be a function of the students' perceptions of the benefits derived from the class. Alternatively it may be due to an attitude or a bias which the students bring with them to their experience with C-BE in the organic chemistry course.

If it is demonstrated that different predispositions are responsible for the observed differences in attitude and performance, there may be a need for orientation procedures to educate students from diverse backgrounds in the

advantages and disadvantages of C-BE as applied to organic chemistry as well as in the most efficient strategies for approaching a C-BE course. Subsequent research will focus upon the determining the actual necessity of such orientation procedures as well as upon a clearer delineation of the attitude and orientation toward college variables discussed in the present paper.

TABLE 1

MEAN GRADE, MEAN SAT SCORES, AND MEAN ATTITUDE COMPARISON FOR APPLIED MAJORS AND NATUPAL SCIENCE MAJORS IN C-BE ORGANIC CHEMISTRY CLASS

	Mean Grade In Course [1]		Mean SAT			Mean Attitude Toward Chemistry [2,3]		Mean Attitude Toward The Computer As A Study Aid [2,3]		Mean Total Attitude [2,4]	
			Verbal	Quantitative	Total						
	Fall	Spring				Fall	Spring	Fall	Spring	Fall	Spring
Applied Majors N = 6	2.00	2.60	482	641	1123	26.67	23.17	23.67	22.83	50.33	46.00
Natural Science Majors N = 6	3.17	3.20	626	682	1308	29.67	25.83	31.50	26.17	61.17	52.00
	F=4.89 p=.05	F=1.80 p=NS	F=6.05 p=.03	F=0.64 p=NS	F=4.50 p=.06	F=0.86 p=NS	F=0.56 p=NS	F=4.76 p=.05	F=6.00 p=NS	F=3.35 p=.09	F=0.72 p=NS

[1]Grades were assigned on a 4-point system: A=4, B=3, C=2, D=1, F=0.

[2]A lower score denotes a more positive attitude.

[3]Forty is a neutral score.

[4]Eighty is a neutral score.

TABLE 2

RANKINGS OF PHILOSOPHIES ON
ORIENTATION TOWARD COLLEGE INVENTORY
FOR STUDENTS IN C-BE ORGANIC CHEMISTRY CLASS

	Vocational	Academic	Social	Identity-seeking
Applied Majors				
S_1 Pharmacy	3	4	2	2
S_2 Pharmacy	1	3	2	4
S_3 Pharmacy	2	3	1	4
S_4 Pharmacy	2	1	3	4
S_5 Pharmacy	2	3	1	4
S_6 Chemical Engineering	1	2	3	4
Mean Ranking	1.83	2.67	2.00	3.67
Natural Science Majors				
S_1 Biology	4	2	3	1
S_2 Chemistry	3	1	2	4
S_3 Chemistry	2	1	3	4
S_4 Chemistry	2	1	3	4
S_5 Chemistry	1	2	3	4
S_6 Chemistry	4	2	3	4
Mean Ranking	2.67	1.50	2.83	3.00

TABLE 3

RANKINGS OF PHILOSOPHIES ON
ORIENTATION TOWARD COLLEGE INVENTORY
FOR STUDENTS IN CONVENTIONAL (NON C-BE) ORGANIC CHEMISTRY CLASS

	Vocational	Academic	Social	Identity-seeking
Applied Majors				
S_1 Pharmacy	1	2	3	4
S_2 Pharmacy	1	3	2	4
S_3 Pharmacy	2	1	3	4
S_4 Pharmacy	1	3	2	4
S_5 Pharmacy	1	4	2	3
S_6 Pharmacy	1	3	2	4
S_7 Pharmacy	1	2	3	4
S_8 Pharmacy	2	3	1	4
S_9 Pharmacy	2	4	1	3
S_{10} Pharmacy	1	2	4	3
S_{11} Chemical Engineering	1	2	3	4
S_{12} Chemical Engineering	4	1	2	3
S_{13} Chemical Engineering	1	2	3	4
S_{14} Chemical Engineering	2	4	1	3
S_{15} Chemical Engineering	1	3	2	4
Mean Rankings	1.47	2.60	2.27	3.67
Natural Science Majors				
S_1 Chemistry	1	3	2	4
S_2 Chemistry	1	2	3	4
S_3 Chemistry	2	3	1	4
S_4 Chemistry	1	2	3	4
S_5 Chemistry	1	2	3	4
S_6 Microbiology	3	1	2	4
S_7 Zoology	2	1	3	4
Mean Rankings	1.57	2.00	2.42	4.00

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